# CORRESPONDENCE/MEMORANDUM

State of Wisconsin

DATE: September 18, 2019

TO: Lisa Lumley – NER

FROM: Wade Strickland – WY/3 Diane Zgid for WS

SUBJECT: Water Quality-Based Effluent Limitations for the Bowler Wastewater Treatment Facility WPDES Permit No. WI-0021327-09

This is in response to your request for an evaluation of the need for water quality-based effluent limitations (WQBELs) using Chapters NR 102, 104, 105, 106, 207, 210, 212, and 217 of the Wisconsin Administrative Code (where applicable), for the discharge from the Bowler Wastewater Treatment Facility in Shawano County. This municipal wastewater treatment facility (WWTF) discharges to the North Branch Embarrass River, located in the North Branch and Mainstem Embarrass River Watershed Watershed in the Wolf River Basin. This discharge is included in the Upper Fox and Wolf River TMDL currently under development. The evaluation of the permit recommendations is discussed in more detail in the attached report.

Based on our review, the following recommendations are made on a chemical-specific basis at Outfall 001:

| Parameter | Daily Maximum | Daily Minimum | Weekly Average | Monthly Average | Footnotes |
|---|---|---|---|---|---|
| $BOD_5$ | | | 45 mg/L | 30 mg/L | 1 |
| TSS | | | 45 mg/L | 30 mg/L | 1,2 |
| pH | 9.0 s.u. | 6.0 s.u. | | | 1 |
| Ammonia Nitrogen | Variable | | **108 mg/L** | **108 mg/L** | 3,4 |
| Fecal Coliform May – September | | | **656#/100 mL** **geometric mean** | 400#/100 mL geometric mean | 3 |
| Phosphorus | | | | | 2 |
| Acute WET | | | | | 5 |
| Chronic WET | | | | | 5 |

Footnotes:

1. No changes from the current permit
2. A Total Maximum Daily Load (TMDL) is being developed for the Upper Fox and Wolf River Basin to address Phosphorus and TSS water quality impairments within the TMDL area. This TMDL will likely result in limitations for phosphorus and TSS that must be included in WPDES permits, which may be different than those calculated for this reissuance. TMDL-derived limits may be included in lieu of or in addition to the calculated limits upon permit reissuance or modification once the TMDL has been approved by U.S. EPA, according to s. NR 217.16, Wis. Adm. Code.
3. Additional limits to comply with the expression of limits requirements in ss. NR 106.07 and NR 205.065(7) are included in bold.
4. The variable daily maximum ammonia nitrogen limit table corresponding to various effluent pH values may be included in the permit in place of the single limit. These limits apply year-round.

| Effluent pH s.u. | Limit mg/L | Effluent pH s.u. | Limit mg/L | Effluent pH s.u. | Limit mg/L |
|---|---|---|---|---|---|
| $6.0 < pH \leq 6.1$ | 108 | $7.0 < pH \leq 7.1$ | 66 | $8.0 < pH \leq 8.1$ | 14 |
| $6.1 < pH \leq 6.2$ | 106 | $7.1 < pH \leq 7.2$ | 59 | $8.1 < pH \leq 8.2$ | 11 |
| $6.2 < pH \leq 6.3$ | 104 | $7.2 < pH \leq 7.3$ | 52 | $8.2 < pH \leq 8.3$ | 9.4 |
| $6.3 < pH \leq 6.4$ | 101 | $7.3 < pH \leq 7.4$ | 46 | $8.3 < pH \leq 8.4$ | 7.8 |
| $6.4 < pH \leq 6.5$ | 98 | $7.4 < pH \leq 7.5$ | 40 | $8.4 < pH \leq 8.5$ | 6.4 |
| $6.5 < pH \leq 6.6$ | 94 | $7.5 < pH \leq 7.6$ | 34 | $8.5 < pH \leq 8.6$ | 5.3 |
| $6.6 < pH \leq 6.7$ | 89 | $7.6 < pH \leq 7.7$ | 29 | $8.6 < pH \leq 8.7$ | 4.4 |
| $6.7 < pH \leq 6.8$ | 84 | $7.7 < pH \leq 7.8$ | 24 | $8.7 < pH \leq 8.8$ | 3.7 |
| $6.8 < pH \leq 6.9$ | 78 | $7.8 < pH \leq 7.9$ | 20 | $8.8 < pH \leq 8.9$ | 3.1 |
| $6.9 < pH \leq 7.0$ | 72 | $7.9 < pH \leq 8.0$ | 17 | $8.9 < pH \leq 9.0$ | 2.6 |

5. No WET testing is required based on Chapter 1.11 of the WET Guidance (WET Testing of Minor Municipal Discharges). This is a minor municipal (< 1.0 MGD) discharge comprised solely of domestic wastewater, with no WET failures and no toxic compounds detected at levels of concern. Because there is a very low risk of toxicity, no WET testing is recommended.

Please consult the attached report for details regarding the above recommendations. If there are any questions or comments, please contact Shaun Shields at (920) 662-5103 or Shaun.Shields@wisconsin.gov Diane Figiel at (608) 264-6274 or Diane.Figiel@wisconsin.gov.

Attachments (2) – Narrative & Map

PREPARED BY: Shaun Shields – Water Resources Engineer

APPROVED BY: Diane Figiel Date: 9/18/19

Diane Figiel, PE,
Water Resources Engineer

E-cc: Roy Van Gheem, Wastewater Engineer – NER
Heidi Schmitt Marquez, Regional Wastewater Supervisor – NER
Diane Figiel, Water Resources Engineer – WY/3

Attachment #1

**Water Quality-Based Effluent Limitations for**
**Bowler Wastewater Treatment Facility**

**WPDES Permit No. WI-002237-09**

Prepared by: Shaun Shields

## PART 1 – BACKGROUND INFORMATION

**Facility Description:**
The treatment system consists of a two-cell aerated lagoon, seasonal UV disinfection, and effluent pH control. The facility is designed to treat an average flow of 33,600 gpd and 133 pounds of BOD per day. The primary aeration basin has a volume of approximately 3 million gallons and is equipped with 14 reef aeration units. Each unit is capable of delivering 2 pounds of oxygen per hour. The units are attached to floats so that they can be lifted for maintenance. The secondary pond also has a volume of about 4 million gallons but only has 5 reef units because about half of the lagoon is a quiescent zone to promote settling prior to discharge. Two 7.5-hp blowers are used to supply the aeration reef units and are housed in a service building. The combined volume of the lagoons provide a detention time of 180 days at the design flow. The treated effluent is discharged to the North Branch Embarrass River.

Attachment #2 is a map of the area showing the approximate location of Outfall 001.

**Existing Permit Limitations:** The current permit, expiring on 12/31/2019, includes the following effluent limitations.

| Parameter | Daily Maximum | Daily Minimum | Weekly Average | Monthly Average | Six-Month Average | Footnotes |
|---|---|---|---|---|---|---|
| $BOD_5$ | | | 45 mg/L | 30 mg/L | | 1 |
| TSS | | | 45 mg/L | 30 mg/L | | 1 |
| pH | 9.0 s.u. | 6.0 s.u. | | | | 1 |
| Ammonia Nitrogen | Daily Max Variable | | | | | 2 |
| Fecal Coliform May – September | | | | 400#/100 mL geometric mean | | |
| Phosphorus | | | | | | 3 |
| Acute WET | | | | | | 4 |

Footnotes:

1. These limitations are not being evaluated as part of this review. Because the water quality criteria (WQC), reference effluent flow rates, and receiving water characteristics have not changed, limitations for these water quality characteristics do not need to be re-evaluated at this time.
2. Daily maximum limit varies with effluent pH. Limits are presented in the table below:

Attachment #1

| Effluent pH - s.u. | $NH_3$-N Limit – mg/L | Effluent pH - s.u. | $NH_3$-N Limit – mg/L |
|---|---|---|---|
| $pH \leq 7.5$ | No Limit | $8.2 < pH \leq 8.3$ | 9.4 |
| $7.5 < pH \leq 7.6$ | 34* | $8.3 < pH \leq 8.4$ | 7.8 |
| $7.6 < pH \leq 7.7$ | 29* | $8.4 < pH \leq 8.5$ | 6.4 |
| $7.7 < pH \leq 7.8$ | 24* | $8.5 < pH \leq 8.6$ | 5.3 |
| $7.8 < pH \leq 7.9$ | 20* | $8.6 < pH \leq 8.7$ | 4.4 |
| $7.9 < pH \leq 8.0$ | 17 | $8.7 < pH \leq 8.8$ | 3.7 |
| $8.0 < pH \leq 8.1$ | 14 | $8.8 < pH \leq 8.9$ | 3.1 |
| $8.1 < pH \leq 8.2$ | 11 | $8.9 < pH \leq 9.0$ | 2.6 |

3. Monitoring only in 2018.
4. Acute WET testing required twice in the permit term.

**Receiving Water Information:**

- Name: North Branch Embarrass River
- Classification: Cold Water, non-public water supply (Cold Water and Public Water Supply criteria are used for bioaccumulating compounds of concern, because the discharge is within the Great Lakes basin.). This receiving water is a Class 2 trout water and a Cold-Water Category 5 Water for the purposes of applying ammonia critieria.
- Low Flow: The following 7-$Q_{10}$ and 7-$Q_2$ values are from USGS for W43, where Outfall 001 is located. The Harmonic Mean has been estimated as recommended in *State of Wisconsin Water Quality Rules Implementation Plan* (Publ. WT-511-98)
  7-$Q_{10}$ = 6 cfs (cubic feet per second)
  7-$Q_2$ = 10 cfs
  Harmonic Mean Flow = 15 cfs
- Hardness = 208 mg/L as $CaCO_3$. This value represents the geometric mean of data from 03/11/1997 – 12/16/1997 collecting from WET testing (n=1) and monitoring station 593124 (n=4) in the North Branch Embarrass River.
- % of low flow used to calculate limits: 25%
- Source of background concentration data: Metals data from Wolf River at Langlade is used for this evaluation because there is no data available for the North Branch of the Embarrass River. The Wolf River is within the same ecological landscape so ambient water quality characteristics are expected to be similar. Chloride data from Tilleda Pond downstream was used for background chloride. The numerical values are shown in the tables below. If no data is available, the background concentration is assumed to be negligible and a value of zero is used in the computations. Background data for calculating effluent limitations for ammonia nitrogen are described later.
- Multiple dischargers: None
- Impaired water status: Approximately 75 miles downstream Lake Poygan in the Wolf River Basin is listed as impaired due to phosphorus and TSS.

**Effluent Information:**

- Design Flow Rate(s):
  Annual average = 0.0336 MGD (Million Gallons per Day)
  For reference, the actual average flow from 01/01/2015 to 07/31/2019 was 0.0258 MGD.

- Hardness = 232 mg/L as $CaCO_3$. This value represents the geometric mean of data from sampling collected for the permit application from 07/15/2019 to 07/25/2019 (n=4).
- Acute dilution factor used: Not applicable – this facility does not have an approved Zone of Initial Dilution (ZID).
- Water Source: Domestic wastewater with no industrial users
- Additives: Sulfuric acid for effluent pH control
- Effluent characterization: This facility is categorized as a minor municipality, so the permit application required effluent sample analyses for a limited number of common pollutants, primarily metal substances plus Ammonia, Chloride, Hardness and Phosphorus.

| Sample Date | Copper µg/L | Chloride mg/L |
|---|---|---|
| 07/15/2019 | <1.6 | 98 |
| 07/18/2019 | <1.6 | 95 |
| 07/22/2019 | <1.6 | 92 |
| 07/25/2019 | <1.6 | 94 |
| **Average** | **<1.6** | **95** |

Effluent data for substances for which a single sample was analyzed is shown in the tables in Part 2 below, in the column titled "MEAN EFFL. CONC.".

The following table presents the average concentrations and loadings at Outfall 001 from 01/01/2015 to 07/31/2019 for all parameters with limits in the current permit to meet the requirements of s. NR 201.03(6):

| | Average Measurement |
|---|---|
| $BOD_5$ | 5.59 mg/L* |
| TSS | 2.97 mg/L* |
| pH field | 7.12 s.u. |
| Fecal Coliform | 110 #/100 mL* |
| Ammonia Nitrogen | 6.93 mg/L* |

*Results below the level of detection (LOD) were included as zeroes in calculation of average.

## PART 2 – WATER QUALITY-BASED EFFLUENT LIMITATIONS FOR TOXIC SUBSTANCES – EXCEPT AMMONIA NITROGEN

In general, permit limits for toxic substances are recommended whenever any of the following occur:

1. The maximum effluent concentration exceeds the calculated limit (s. NR 106.05(3), Wis. Adm. Code)
2. If 11 or more detected results are available in the effluent, the upper 99th percentile (or $P_{99}$) value exceeds the comparable calculated limit (s. NR 106.05(4), Wis. Adm. Code)
3. If fewer than 11 detected results are available, the mean effluent concentration exceeds 1/5 of the calculated limit (s. NR 106.05(6), Wis. Adm. Code)

**Acute Limits based on 1-$Q_{10}$**

Daily maximum effluent limitations for toxic substances are based on the acute toxicity criteria (ATC), listed in ch. NR 105, Wis. Adm. Code. Previously daily maximum limits for toxic substances were calculated as two times the ATC. However, changes to ch. NR 106, Wis. Adm. Code (September 1, 2016) require the Department to calculate acute limitations using the same mass balance equation as used for other limits along with the 1-$Q_{10}$ receiving water low flow to determine if more restrictive effluent limitations are needed to protect the receiving stream from discharges which may cause or contribute to an exceedance of the acute water quality standards.

$$\text{Limitation} = \frac{(WQC)\,(Qs + (1-f)\,Qe) - (Qs - f\,Qe)\,(Cs)}{Qe}$$

Where:

WQC =Acute toxicity criterion or secondary acute value according to ch. NR 105

Qs = average minimum 1-day flow which occurs once in 10 years (1-day $Q_{10}$) if the 1-day $Q_{10}$ flow data is not available = 80% of the average minimum 7-day flow which occurs once in 10 years (7-day $Q_{10}$).

Qe = Effluent flow (in units of volume per unit time) as specified in s. NR 106.06(4)(d)

f = Fraction of the effluent flow that is withdrawn from the receiving water, and

Cs = Background concentration of the substance (in units of mass per unit volume) as specified in s. NR 106.06(4)(e).

As a rule of thumb, if the receiving water is effluent dominated under low stream flow conditions, the 1-$Q_{10}$ method of limit calculation produces the most stringent daily maximum limitations and should be used while making reasonable potential determinations. This is not the case for Bowler Wastewater Treatment Facility.

The following tables list the water quality-based effluent limitations for this discharge along with the results of effluent sampling for all the detected substances. All concentrations are expressed in terms of micrograms per Liter (µg/L), except for hardness and chloride (mg/L).

**Daily Maximum Limits based on Acute Toxicity Criteria (ATC)**

RECEIVING WATER FLOW = 4.8 cfs, (1-$Q_{10}$ (estimated as 80% of 7-$Q_{10}$)).

| SUBSTANCE | REF. HARD. mg/L | ATC | MEAN BACK-GRD. | MAX. EFFL. LIMIT** | 1/5 OF EFFL. LIMIT | MEAN EFFL. CONC. | 1-day MAX. CONC. |
|---|---|---|---|---|---|---|---|
| Arsenic | | 340 | | 680 | 136 | <1.0 | |
| Cadmium | 232 | 11.4 | 0.08 | 22.9 | 4.6 | <0.19 | |
| Chromium | 232 | 3592 | 0.13 | 7184 | 1437 | <0.83 | |
| Copper | 232 | 34.3 | 0.26 | 68.7 | 13.7 | <1.6 | |
| Lead | 232 | 241 | 0.18 | 482 | 96.4 | <4.3 | |
| Nickel | 232 | 956 | | 1912 | 382 | <1.1 | |
| Zinc | 232 | 251 | 0.63 | 503 | 101 | 3.80 | |
| Chloride (mg/L) | | 757 | 8.0 | 1514 | 303 | 95 | 98 |

* * The 2 × ATC method of limit calculation yields a more restrictive limit than consideration of ambient concentrations and 1-$Q_{10}$ flow rates per the changes to s. NR 106.07(3), Wis. Adm. Code, effective 09/01/2016.

Attachment #1

**Weekly Average Limits based on Chronic Toxicity Criteria (CTC)**

RECEIVING WATER FLOW = 1.5 cfs (¼ of the 7-$Q_{10}$)

| SUBSTANCE | REF. HARD.* mg/L | CTC | MEAN BACK-GRD. | WEEKLY AVE. LIMIT | 1/5 OF EFFL. LIMIT | MEAN EFFL. CONC. |
|---|---|---|---|---|---|---|
| Arsenic | | 148 | | 4418 | 884 | <1.0 |
| Cadmium | 175 | 3.82 | 0.08 | 112 | 22.3 | <0.19 |
| Chromium | 208 | 157 | 0.13 | 4685 | 937 | <0.83 |
| Copper | 208 | 19.4 | 0.26 | 571 | 114 | <1.6 |
| Lead | 208 | 56.8 | 0.18 | 1691 | 338 | <4.3 |
| Nickel | 208 | 96.9 | | 2895 | 579 | <1.1 |
| Zinc | 208 | 228 | 0.63 | 6800 | 1360 | 3.80 |
| Chloride (mg/L) | | 395 | 8.00 | 11561 | 2312 | 95 |

* The indicated hardness may differ from the receiving water hardness because the receiving water hardness exceeded the maximum range in ch. NR 105, Wis. Adm. Code, over which the chronic criteria are applicable. In that case, the maximum of the range is used to calculate the criterion.

**Monthly Average Limits based on Wildlife Criteria (WC)**

The effluent characterization did not include any effluent sampling results for substances for which Wildlife Criteria exist.

**Monthly Average Limits based on Human Threshold Criteria (HTC)**

RECEIVING WATER FLOW = 3.75 cfs (¼ of the Harmonic Mean)

| SUBSTANCE | HTC | MEAN BACK-GRD. | MO'LY AVE. LIMIT | 1/5 OF EFFL. LIMIT | MEAN EFFL. CONC. |
|---|---|---|---|---|---|
| Cadmium | 370 | 0.08 | 27088 | 5417 | <0.19 |
| Chromium (+3) | 3818000 | 0.13 | 2.80E+08 | 5.59E+07 | <0.83 |
| Lead | 140 | 0.18 | 10239 | 2048 | <4.3 |
| Nickel | 43000 | | 3.15E+06 | 6.30E+05 | <1.1 |

**Monthly Average Limits based on Human Cancer Criteria (HCC)**

RECEIVING WATER FLOW = 3.75 cfs (¼ of the Harmonic Mean)

| SUBSTANCE | HCC | MEAN BACK-GRD. | MO'LY AVE. LIMIT | 1/5 OF EFFL. LIMIT | MEAN EFFL. CONC. |
|---|---|---|---|---|---|
| Arsenic | 13.3 | | 974 | 195 | <1.0 |

In addition to evaluating the need for limits for each individual substance for which HCC exist, s. NR 106.06(8) requires the evaluation of the cumulative cancer risk. Because effluent data is available for only one substance for which Human Cancer Criteria exists, and it was not detected in the effluent, determination of the cumulative cancer risk is not needed per s. NR 106.06(8), Wis. Adm. Code.

**Conclusions and Recommendations:** Based on a comparison of the effluent data and calculated effluent limitations, no effluent limits are recommended.

Mercury – The permit application did not require monitoring for mercury because the Bowler Wastewater Treatment Facility is categorized as a minor facility as defined in s. NR 200.02(8), Wis. Adm. Code. In accordance with s. NR 106.145(3)(a)3., a minor municipal discharger shall monitor, and report results of influent and effluent mercury monitoring once every three months if, "there are two or more exceedances in the last five years of the high-quality sludge mercury concentration of 17 mg/kg specified in s. NR 204.07(5)." A review of the past five years of sludge characteristics data reveals that all the sample results are within expected analytical ranges and well below the 17 mg/kg level. The average concentration in the sludge from 06/14/2019 was non-detect. Therefore, no mercury monitoring is recommended at Outfall 001.

## PART 3 – WATER QUALITY-BASED EFFLUENT LIMITATIONS FOR AMMONIA NITROGEN

The State of Wisconsin promulgated revised water quality standards for ammonia nitrogen effective March 1, 2004 which includes criteria based on both acute and chronic toxicity to aquatic life. The current permit has daily maximum, weekly average and monthly average limits for Outfall 001 (calculated in 2012). These limits are re-evaluated at this time due to the following changes:

- Updates to subchapter IV of ch. NR 106, Wis. Adm. Code allow limits based on available dilution instead of limits set to twice the acute criteria.
- Updates to s. NR 106.07(3), Wis. Adm. Code require weekly and monthly average limits for municipal treatment plants.
- Seasonal 20 and 40 mg/L thresholds for ammonia limits are no longer applicable under current rules.
- Bowler Wastewater Treatment Facility does not currently have weekly or monthly average ammonia limits.

**Daily Maximum Limits based on Acute Toxicity Criteria (ATC):**
Daily maximum limitations are based on acute toxicity criteria, which are a function of the effluent pH and the receiving water classification. The acute toxicity criterion (ATC) for ammonia is calculated using the following equation.

$$ATC \text{ in mg/L} = [A \div (1 + 10^{(7.204 - pH)})] + [B \div (1 + 10^{(pH - 7.204)})]$$

Where:

A = 0.411 and B = 58.4 for a Cold-Water Category 5 fishery, and
pH (s.u.) = that characteristic of the effluent.

The effluent pH data was examined as part of this evaluation. A total of 481 sample results were reported from 01/01/2015 to 07/30/2019. The maximum reported value was 7.5 s.u. (Standard pH Units). The effluent pH was 7.5 s.u. or less 99% of the time. The 1-day $P_{99}$, calculated in accordance with s. NR 106.05(5), is 7.61 s.u. And the mean plus the standard deviation multiplied by a factor of 2.33, an estimate of the upper ninety ninth percentile for a normally distributed dataset, is 7.6 s.u. Therefore, a value of 7.6 s.u. is believed to represent the maximum reasonably expected pH, and therefore most appropriate for determining daily maximum limitations for ammonia nitrogen. Substituting a value of 7.6 s.u. into the equation above yields an ATC = 17 mg/L and a computed daily maximum limit of 34 mg/L using two times the ATC.

**Potential Changes to Daily Maximum Ammonia Nitrogen Effluent Limitations:**
Updates to subchapter IV of ch. NR 106, Wis. Adm. Code (effective September 1, 2016) outline the option for the Department to implement use of the 1-$Q_{10}$ receiving water low flow to calculate daily maximum ammonia nitrogen limits if it is determined that the previous method of acute ammonia limit calculation (2×ATC) is not sufficiently protective of the fish and aquatic life. The more restrictive calculated limits would apply.

The calculated daily maximum ammonia nitrogen effluent limits using the mass balance approach with the 1-$Q_{10}$ (estimated as 80 % of 7-$Q_{10}$) and the 2×ATC approach are shown below.

| | Ammonia Nitrogen Limit mg/L |
|---|---|
| 2×ATC | 34 |
| 1-$Q_{10}$ | 1586 |

The 2×ATC method yields the most stringent limits for Bowler Wastewater Treatment Facility.

The current permit has variable daily maximum effluent limits based on effluent pH. Presented below is a table of daily maximum limitations corresponding to various effluent pH values This table has been expanded from the previous table due to the changes in s. NR 106.33(2).

**Daily Maximum Ammonia Nitrogen Limits – Cold Water Category 5**

| Effluent pH s.u. | Limit mg/L | Effluent pH s.u. | Limit mg/L | Effluent pH s.u. | Limit mg/L |
|---|---|---|---|---|---|
| $6.0 < pH \leq 6.1$ | 108 | $7.0 < pH \leq 7.1$ | 66 | $8.0 < pH \leq 8.1$ | 14 |
| $6.1 < pH \leq 6.2$ | 106 | $7.1 < pH \leq 7.2$ | 59 | $8.1 < pH \leq 8.2$ | 11 |
| $6.2 < pH \leq 6.3$ | 104 | $7.2 < pH \leq 7.3$ | 52 | $8.2 < pH \leq 8.3$ | 9.4 |
| $6.3 < pH \leq 6.4$ | 101 | $7.3 < pH \leq 7.4$ | 46 | $8.3 < pH \leq 8.4$ | 7.8 |
| $6.4 < pH \leq 6.5$ | 98 | $7.4 < pH \leq 7.5$ | 40 | $8.4 < pH \leq 8.5$ | 6.4 |
| $6.5 < pH \leq 6.6$ | 94 | $7.5 < pH \leq 7.6$ | 34 | $8.5 < pH \leq 8.6$ | 5.3 |
| $6.6 < pH \leq 6.7$ | 89 | $7.6 < pH \leq 7.7$ | 29 | $8.6 < pH \leq 8.7$ | 4.4 |
| $6.7 < pH \leq 6.8$ | 84 | $7.7 < pH \leq 7.8$ | 24 | $8.7 < pH \leq 8.8$ | 3.7 |
| $6.8 < pH \leq 6.9$ | 78 | $7.8 < pH \leq 7.9$ | 20 | $8.8 < pH \leq 8.9$ | 3.1 |
| $6.9 < pH \leq 7.0$ | 72 | $7.9 < pH \leq 8.0$ | 17 | $8.9 < pH \leq 9.0$ | 2.6 |

**Weekly Average & Monthly Average Limits based on Chronic Toxicity Criteria (CTC)**
The ammonia limit calculation also warrants evaluation of weekly and monthly average limits based on chronic toxicity criteria for ammonia, since those limits relate to the assimilative capacity of the receiving water.

Weekly average and monthly average limits for ammonia nitrogen are based on chronic toxicity criteria.

The 30-day chronic toxicity criterion (CTC) for ammonia in waters classified for a Cold Water Community is calculated by the following equation.

$$CTC = E \times \{[0.0676 \div (1 + 10^{(7.688 - pH)})] + [2.912 \div (1 + 10^{(pH - 7.688)})]\} \times C$$

Where:

pH = the pH (s.u.) of the receiving water,
E = 0.854,
C = the minimum of 2.85 or $1.45 \times 10^{(0.028 \times (25 - T))}$
T = the temperature (°C) of the receiving water

The 4-day criterion is simply equal to the 30-day criterion multiplied by 2.5. The 4-day criteria are used in a mass-balance equation with the 7-$Q_{10}$ (4-$Q_3$, if available) to derive weekly average limitations. And the 30-day criteria are used with the 30-$Q_5$ (estimated as 85% of the 7-$Q_2$ if the 30-$Q_5$ is not available) to derive monthly average limitations. The stream flow value is further adjusted to temperature; 100% of the flow is used if the Temperature ≥ 16 °C, 25% of the flow is used if the Temperature < 11 °C, and 50% of the flow is used if the Temperature ≥ 11 °C but < 16 °C.

Since minimal ambient data is available, the "default" basin assumed values are used for Temperature and background ammonia concentrations, however pH data from several monitoring stations located in the North, South, and main stem of the Embarrass River was used for this evaluation. Field pH data from the following SWIMS Station IDs were used for this evaluation: 363289, 593124, 593125, 593126, 593129, 593158, 593163, 593164, 10021390, 10028748, 10028983, 10030462, 10034819, 10037962, 10039809, 10039811, 10048417. These values are shown in the table below, with the resulting criteria and effluent limitations.

| | | Spring<br>April & May | Summer<br>June – Sept. | Winter<br>Oct. - March |
|---|---|---|---|---|
| **Effluent Flow** | Qe (MGD) | 0.0336 | 0.0336 | 0.0336 |
| **Background Information** | 7-$Q_{10}$ (cfs) | 6 | 6 | 6 |
| | 7-$Q_2$ (cfs) | 10 | 10 | 10 |
| | Ammonia (mg/L) | 0.04 | 0.03 | 0.07 |
| | Temperature (°C) | 11 | 16 | 4 |
| | pH (s.u.) | 7.82 | 7.87 | 7.79 |
| | % of Flow used | 25 | 100 | 25 |
| | Reference Weekly Flow (cfs) | 1.5 | 6 | 1.5 |
| | Reference Monthly Flow (cfs) | 2.13 | 8.50 | 2.13 |
| **Criteria mg/L** | 4-day Chronic | **7.76** | **5.90** | **8.05** |
| | 30-day Chronic | **3.10** | **2.36** | **3.22** |
| **Effluent Limits mg/L** | Weekly Average | **231** | **683** | **238** |
| | Monthly Average | **128** | **383** | **132** |

**Effluent Data**

The following table evaluates the statistics based upon ammonia data reported from 01/01/2015 to 07/23/2019, with those results being compared to the calculated limits to determine the need to include weekly average and monthly average ammonia limits in the Bowler Wastewater Treatment Facility permit for the respective month ranges. That need is determined by calculating 99th upper percentile (or $P_{99}$) values for ammonia during each of the month ranges and comparing the daily maximum values to the daily maximum limit. Based on this comparison, only daily limits would be recommended, however the permit currently contains daily maximum ammonia limits.

Attachment #1

| Ammonia Nitrogen mg/L | April – May | June – September | October – March |
|---|---|---|---|
| 1-day $P_{99}$ | 33.2 | 21.7 | 35.1 |
| 4-day $P_{99}$ | 21.1 | 11.8 | 19.3 |
| 30-day $P_{99}$ | 14.90 | 5.84 | 10.93 |
| Mean* | 12.02 | 3.44 | 7.38 |
| Std | 6.23 | 4.62 | 7.2 |
| Sample size | 40 | 72 | 108 |
| Range | <0.016 - 23.9 | <0.016 - 20.2 | <0.016 - 32.9 |

**Antidegradation:**
Where there are existing ammonia nitrogen limits in the permit, the limits are recommended to be retained regardless of reasonable potential, consistent with s. NR 106.33(1), Wis. Adm. Code:

> (b) If a permittee is subject to an ammonia limitation in an existing permit, the limitation shall be included in any reissued permit. Ammonia limitations shall be included in the permit if the permitted facility will be providing treatment for ammonia discharges.

**Conclusions and Recommendations:**
In summary, after rounding to two significant figures, the following daily maximum variable ammonia nitrogen limitations are recommended. No mass limitations are recommended in accordance with s. NR 106.32(5). Additional limits to comply with expression of limit requirements are outlined in Part 7 of this document.

| Effluent pH s.u. | Limit mg/L | Effluent pH s.u. | Limit mg/L | Effluent pH s.u. | Limit mg/L |
|---|---|---|---|---|---|
| $6.0 < pH \leq 6.1$ | 108 | $7.0 < pH \leq 7.1$ | 66 | $8.0 < pH \leq 8.1$ | 14 |
| $6.1 < pH \leq 6.2$ | 106 | $7.1 < pH \leq 7.2$ | 59 | $8.1 < pH \leq 8.2$ | 11 |
| $6.2 < pH \leq 6.3$ | 104 | $7.2 < pH \leq 7.3$ | 52 | $8.2 < pH \leq 8.3$ | 9.4 |
| $6.3 < pH \leq 6.4$ | 101 | $7.3 < pH \leq 7.4$ | 46 | $8.3 < pH \leq 8.4$ | 7.8 |
| $6.4 < pH \leq 6.5$ | 98 | $7.4 < pH \leq 7.5$ | 40 | $8.4 < pH \leq 8.5$ | 6.4 |
| $6.5 < pH \leq 6.6$ | 94 | $7.5 < pH \leq 7.6$ | 34 | $8.5 < pH \leq 8.6$ | 5.3 |
| $6.6 < pH \leq 6.7$ | 89 | $7.6 < pH \leq 7.7$ | 29 | $8.6 < pH \leq 8.7$ | 4.4 |
| $6.7 < pH \leq 6.8$ | 84 | $7.7 < pH \leq 7.8$ | 24 | $8.7 < pH \leq 8.8$ | 3.7 |
| $6.8 < pH \leq 6.9$ | 78 | $7.8 < pH \leq 7.9$ | 20 | $8.8 < pH \leq 8.9$ | 3.1 |
| $6.9 < pH \leq 7.0$ | 72 | $7.9 < pH \leq 8.0$ | 17 | $8.9 < pH \leq 9.0$ | 2.6 |

## PART 4 –PHOSPHORUS

**Technology Based Effluent Limit (TBL)**
Wisconsin Administrative Code, ch. NR 217, requires municipal wastewater treatment facilities that discharge greater than 150 pounds of Total Phosphorus per month to comply with a monthly average limit of 1.0 mg/L, or an approved alternative concentration limit.

Because Bowler Wastewater Treatment Facility does not currently have an existing technology-based limit, the need for this limit in the reissued permit is evaluated. The data demonstrates that the annual monthly average phosphorus loading is less than 150 lbs/month, which is the threshold for municipalities in accordance to s. NR 217.04(1)(a)1, and therefore no technology-based limit is recommended.

| Sample Date | Monthly Avg. mg/L | Total Flow MG/month | Total Phosphorus lb./mo. |
|---|---|---|---|
| Jan 2018 | 4.5 | 0.549 | 20.6 |
| Feb 2018 | 5.9 | 0.558 | 27.2 |
| Mar 2018 | 6.6 | 0.634 | 34.9 |
| April 2018 | 6.7 | 0.741 | 41.1 |
| May 2018 | 6.1 | 0.632 | 32.2 |
| June 2018 | 6.4 | 0.579 | 30.6 |
| July 2018 | 6.1 | 0.506 | 25.7 |
| Aug 2018 | 7.0 | 0.729 | 42.2 |
| Sept 2018 | 7.1 | 0.616 | 36.5 |
| Oct 2018 | 5.5 | 0.870 | 39.9 |
| Nov 2018 | 4.0 | 0.786 | 26.2 |
| Dec 2018 | 3.6 | 0.691 | 20.7 |
| Average: 32 lbs/month | | | |

Total P (lbs/month) = Monthly average (mg/L) × total flow (MGD) × 8.34 (lbs/gallon)
Where total flow is the sum of the actual (not design) flow (in MGD) for that month

In addition, the need for a WQBEL for phosphorus must be considered.

**Water Quality-Based Effluent Limits (WQBEL)**

Revisions to administrative rules regulating phosphorus took effect on December 1, 2010. These rule revisions include additions to ch. NR 102 (s. NR 102.06), which establish phosphorus standards for surface waters. Revisions to ch. NR 217 (s. NR 217, Subchapter III) establish procedures for determining WQBELs for phosphorus, based on the applicable standards in ch. NR 102.

Section NR 102.06(3)(a) specifically names river segments for which a phosphorus criterion of 0.100 mg/L applies. For other stream segments that are not specified in s. NR 102.06(3)(a), s. NR 102.06(3)(b), Wis. Adm. Code, specifies a phosphorus criterion of 0.075 mg/L. The phosphorus criterion of 0.075 mg/L applies for the North Branch Embarrass River.

The conservation of mass equation is described in s. NR 217.13 (2)(a), Wis. Adm. Code, for phosphorus WQBELs and includes variables of water quality criterion (WQC), receiving water flow rate (Qs), effluent flow rate (Qe), and upstream phosphorus concentrations (Cs):

$$\text{Limitation} = [(WQC)(Qs+(1-f)\ Qe) - (Qs-f\ Qe)\ (Cs)]/Qe$$

Where:

WQC = 0.075 mg/L for North Branch Embarrass River.
Qs = 100% of the 7-$Q_2$ of 10 cfs
Cs = background concentration of phosphorus in the receiving water pursuant to s. NR 217.13(2)(d), Wis. Adm. Code

Qe = effluent flow rate = 0.0336 MGD = 0.0519 cfs
f = the fraction of effluent withdrawn from the receiving water = 0

A previous evaluation resulted in a WQBEL of 8.2 mg/L using a background concentration of 0.032 mg/L. Section NR 217.13(2)(d) states that the determination of upstream concentrations shall be evaluated at each permit reissuance. Additional data were considered in estimating the background phosphorus concentration.

A review of all available in stream total phosphorus data from six samples collected from 05/20/2008 to 07/14/2009 stored in the Surface Water Integrated Monitoring System database indicates the median background total phosphorus concentration in North Branch Embarrass River at CTH D (SWIMS station ID #10028748) is 0.032 mg/L, downstream from the point of discharge to North Branch Embarrass River. No additional monitoring has been performed in proximity to the outfall. It is expected for the receiving water to not have a significant change in in-stream phosphorus concentration due to the surrounding land use.

Substituting a median value of 0.032 mg/L into the limit calculation equation above, the calculated limit is 8.2 mg/L.

**Effluent Data**
The following table summarizes effluent total phosphorus monitoring data from 01/03/2018 to 12/18/2018.

| | **Phosphorus mg/L** |
|---|---|
| 1-day $P_{99}$ | 9.2 |
| 4-day $P_{99}$ | 7.3 |
| 30-day $P_{99}$ | 6.31 |
| Mean | 5.78 |
| Std | 1.21 |
| Sample size | 24 |
| Range | 2.7 - 7.3 |

**Reasonable Potential Determination**
Since the 30-day $P_{99}$ of reported effluent total phosphorus data is below the calculated WQBEL, **the discharge does not have reasonable potential to cause or contribute to an exceedance of the water quality criterion.** Therefore, **a WQBEL is not recommended.**

**TMDL Under Development**
A Total Maximum Daily Load (TMDL) is being developed for the Upper Fox and Wolf River Basin for phosphorus and TSS. The TMDL will address phosphorus and TSS water quality impairments within the basins and provide waste load allocations (WLA) required to meet water quality standards. This TMDL will likely result in phosphorus and TSS limitations that must be included in WPDES permits. TMDL-derived phosphorus limits may be included in lieu of or in addition to the calculated limits upon permit reissuance or modification once the TMDL has been approved by U.S. EPA, according to s. NR 217.16, Wis. Adm. Code.

Attachment #1

## PART 5 –THERMAL

New surface water quality standards for temperature took effect on October 1, 2010. These new regulations are detailed in chs. NR 102 (Subchapter II – Water Quality Standards for Temperature) and NR 106 (Subchapter V – Effluent Limitations for Temperature) of the Wisconsin Administrative Code. Daily maximum and weekly average temperature criteria are available for the 12 different months of the year depending on the receiving water classification.

In accordance with s. NR 106.53(2)(b), the highest daily maximum flow rate for a calendar month is used to determine the acute (daily maximum) effluent limitation. In accordance with s. NR 106.53(2)(c), the highest 7-day rolling average flow rate for a calendar month is used to determine the sub-lethal (weekly average) effluent limitation. These values were based off actual flow reported from 01/01/2015 to 07/31/2019.

No effluent temperature monitoring is available.

| Month | Calculated Effluent Limit | |
|---|---|---|
| | Weekly Average Effluent Limitation (°F) | Daily Maximum Effluent Limitation (°F) |
| JAN | NA | 120 |
| FEB | NA | 120 |
| MAR | NA | 120 |
| APR | NA | 120 |
| MAY | NA | 120 |
| JUN | NA | 120 |
| JUL | NA | 120 |
| AUG | 102 | 120 |
| SEP | 117 | 120 |
| OCT | NA | 120 |
| NOV | NA | 120 |
| DEC | NA | 120 |

**Reasonable Potential**

At temperatures above ~103°F, conventional biological treatment systems stop functioning properly and experience upsets. There is no indication that this has ever occurred at this treatment system. This information, coupled with the lack of industrial heat load, lead to the conclusion that there is no reasonable potential for the discharge to exceed the 102°F limitation. Municipal treatment systems with no industrial contributors are unlikely to exceed a 102°F limit, therefore no limit or monitoring is recommended to be included in the reissued permit for temperature.

## PART 6 – WHOLE EFFLUENT TOXICITY (WET)

WET testing is used to measure, predict, and control the discharge of toxic materials that may be harmful to aquatic life. In WET tests, organisms are exposed to a series of effluent concentrations for a given time and effects are recorded. The following evaluation is based on procedures in the Department's WET Program Guidance Document (revision #11, dated November 1, 2016).

The WET Checklist was not used to evaluate this discharge. Instead, guidance in Chapter 1.11 of the WET Guidance (WET Testing of Minor Municipal Discharges) was consulted. This is a minor municipal (< 1.0 MGD) discharge comprised solely of domestic wastewater, with no WET failures and no toxic compounds detected at levels of concern. Because there is a very low risk of toxicity, no WET testing is recommended at this time.

## PART 7 – EXPRESSION OF LIMITS

Revisions to chs. NR 106 and 205, Wis. Adm. Code align Wisconsin's water quality-based effluent limits with 40 CFR 122.45(d), which requires WPDES permits contain the following concentration limits, whenever practicable and necessary to protect water quality:

- Weekly average and monthly average limitations for continuous discharges subject to ch. NR 210.
- Daily maximum and monthly average limitations for all other discharges.

Bowler Wastewater Treatment Facility is a municipal treatment facility and is therefore subject to weekly average and monthly average limitations whenever limitations are determined to be necessary.

This evaluation provides additional limitations necessary to comply with the expression of limits in ss. NR 106.07 and NR 205.065(7), Wis. Adm. Code. Pollutants already compliant with these rules or that have an approved impracticability demonstration, are excluded from this evaluation including water-quality based effluent limitations for phosphorus, temperature, and pH, among other parameters. Mass limitations are not subject to the limit expression requirements if concentrations limits are given.

**Method for calculation:**
The methods for calculating limitations for continuous discharges subject to ch. NR 210 to conform to 40 CFR 122.45(d) are specified in s. NR 106.07(3), and are as follows:

- Whenever a daily maximum limitation is determined necessary to protect water quality, a weekly and monthly average limitation shall also be included in the permit and set equal to the daily maximum limit unless a more restrictive limit is already determined necessary to protect water quality.
    - Ammonia Nitrogen – In this case the recommended daily maximum limits vary with effluent pH, so additional limits should be set equal to the highest recommended limit. Therefore, **monthly and weekly average limits of 108 mg/L** are recommended in the permit.

- Whenever a weekly average limitation is determined necessary to protect water quality, a monthly average limitation shall also be included in the permit and set equal to the weekly average limit unless a more restrictive limit is already determined necessary to protect water quality.

- Whenever a monthly average limitation is determined necessary to protect water quality, a weekly average limit shall be calculated using the following procedure and included in the permit unless a more restrictive limit is already determined necessary to protect water quality:

  Weekly Average Limitation = (Monthly Average Limitation × MF)

  Where:

  MF= Multiplication factor as defined in Table 1

  CV= coefficient of variation (CV) as calculated in s. NR 106.07(5m)

  n= the number of samples per month required in the permit

s. NR 106.07 (3) (e) 4. Table 1 — Multiplication Factor (for CV = 0.6)

| CV | n=1 | n=2 | n=3 | n=4 | n=8 | n=12 | n=16 | n=20 | n=24 | n=30 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.6 | 1.00 | 1.31 | 1.51 | **1.64** | 1.95 | 2.12 | 2.23 | 2.30 | 2.36 | 2.43 |

Note: This methodology is based on the *Technical Support Document for Water Quality-based Toxics Control* (March 1991). PB91-127415.

- Fecal Coliform – A weekly geometric mean limit of 656 #/100mL is calculated using the default CV of 0.6 and associated multiplication factor of 1.64 based on a weekly monitoring frequency.

**Summary of Additional Limitations:**

In conclusion, the following additional limitations are required to comply with ss. NR 106.07 and NR 205.065(7) Expression of Limits.

| Parameter | Daily Maximum | Weekly Average | Monthly Average | Weekly Geometric Mean | Monthly Geometric Mean | Multiplication Factor (CV) | Assumed Monitoring Frequency (n) |
|---|---|---|---|---|---|---|---|
| Fecal Coliform | | | | **656 #/100mL** | 400 #/100mL | 1.64 (0.6) | Weekly (4) |
| Ammonia Nitrogen | Variable | **108 mg/L** | **108 mg/L** | | | | |

Attachment #2

## Map of Outfall